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Topographical condition of mild steel after an orthogonal cutting

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Abstract

Now a days it is very common interest for engineers to improve the surface quality. Improvement of surface quality deals with several factors like cutting condition, heat generation, heat dissipation, selection of cutting fluid etc. Above all the factors it is very important to know about the change in microstructure and behavior of the material. The surface quality that is the change in microstructure greatly depends on the cutting condition and process which are taken on account earlier, each of which produce a surface with own characteristic topography. In this paper the topographical condition of a mild steel workpiece and chip is investigated and described. For this purpose an orthogonal cutting of mild steel metal with cutting tool of high speed metal is taken. The change in microstructure of chip and work material is observed in the metallurgical microscope. Then finally it is observed, the total change of microstructure of each surface held with the proportion of heat generation and distribution.

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Keywords: Specimen topography; heat generation; heat dissipation; microstructure

1. Introduction

For the production of variety metallic products metal removal operations are widely used in industry. During metal removal process the first objective is to obtain a smooth surface. The metal surface smoothness is greatly depends on the machining process. The basic principle of metal removal is that the heat generation between tool and work material contact surface with friction. The heat generation is closely related to the plastic deformation and friction [1]. It can be specified that three main source of heat during machining or cutting e.g. plastic deformation by shearing in the primary shear zone, plastic deformation by shearing and friction on the cutting face and friction between chip and tool on tool flank. The generated heat is mostly dissipated by discarded chip when no cutting fluid is used and the rest amount also draws away by cutting tool. The change in micro structure of mild steel interface occurs due to temperature. Different temperature distribution between chip and work material is observed [2]. By this observation it is shown that the amount of change in the different interface of mild steel with equally distribution of heat at different planes and faces. The microstructure analysis of the mild steel interfaces obtains by high speed cutting. In this work an orthogonal cutting of mild steel has done. Then the chip and work material topography observed at metallurgical microscope and compared with actual microstructure of mild steel. The paper is organized as follows, Experimental details provides the cutting technique, chip formation and process of taking image. The result section provides the microstructure images acquisition. Finally the comparison of topographical condition of mild steel and work experience is figured out in discussion and conclusion section.

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2. **Experimental details**

The material examined was a mild steel specimen. Before setting for an orthogonal cutting the general topographical characteristics was observed in metallurgical microscope. And this also carried out by some steps which are not concerned matter of this work. The specimen then placed into a lathe machine for cutting at different speed and obtained the chip. The cutting was carried out at 700 rpm and 800 rpm. Then specimen and chips collected together for visualizing the topographical microstructure. The metallographic observations were carried out on both sample cut surface and chip. The microstructure features of the specimen and chip were characterized by optical and SEM observation. The metallurgical microscope was of Advanced Metallurgical Microscope type.

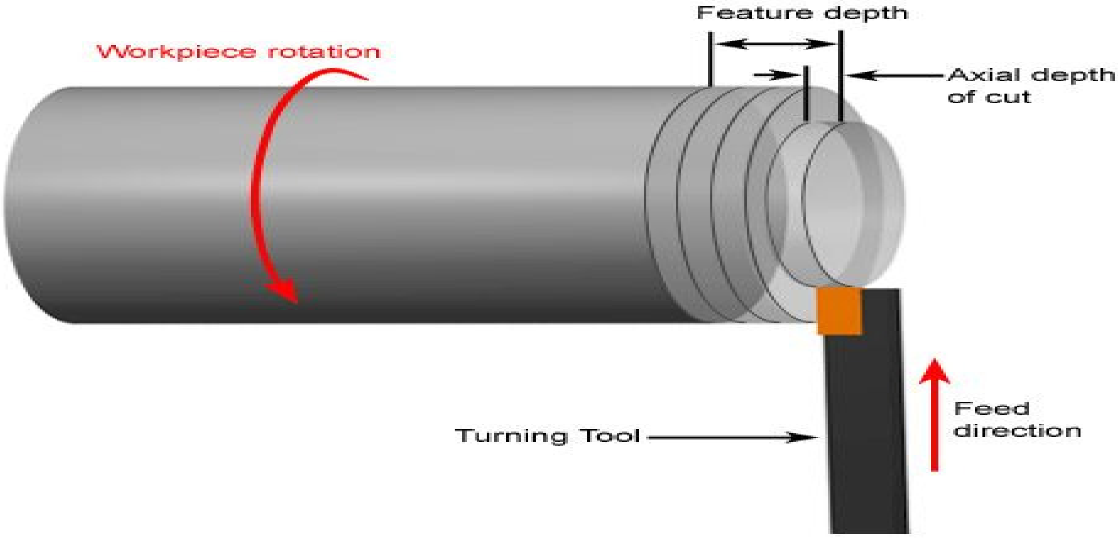

Fig.1. Typical orthogonal metal cutting

3. Results

Figure 2 shows the microstructure of mild steel specimen before cutting. It contains about .1% carbon in weight alloyed with iron. This steel has two major constituents, which are ferrite and pearlite. The light coloured region of the microstructure is ferrite. The grain boundaries between the ferrite grains can be seen quite clearly. The dark region is pearlite. It made up from a fine mixture of ferrite and iron carbide. The small spots within the ferrite grains could be exhibits. These are illusions and impurities such as oxide and sulphide.

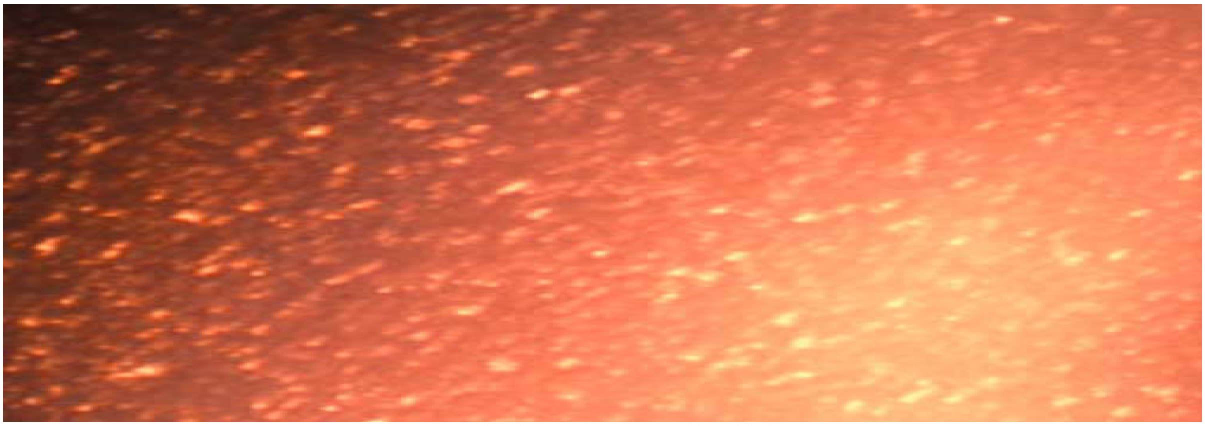

Fig. 2. Topographical microstructure of mild steel before cutting

The properties of mild steel greatly depend on the microstructure. Decreasing the size of the grains and decreasing the amount of pearlite develops the strength ductility and toughness of the steel. The inclusion can also affect the toughness. Figure 3 shows the topographical microstructure of the chip of mild steel after cutting. And figure 4 shows the microstructure of mild steel workpiece surface after cutting. The microstructure of the mild steel sample surface shows a rough structure of grained ferrite and pearlite with effect of bending and heat. Similarly in figure 3 also shows the rough structure of grain ferrite and pearlite with effect of bending and heat. According to the assumption of heat generation and distribution it is observed, the change in microstructure of chip is more affected by heat than the structure of workpiece surface. The microstructure changes observed are due to the fact that during cutting recrystalyzation and grain growths are interacting in a complex way to determine final grain size. The new grain size obviously disrupted by the heat which generated during cutting.

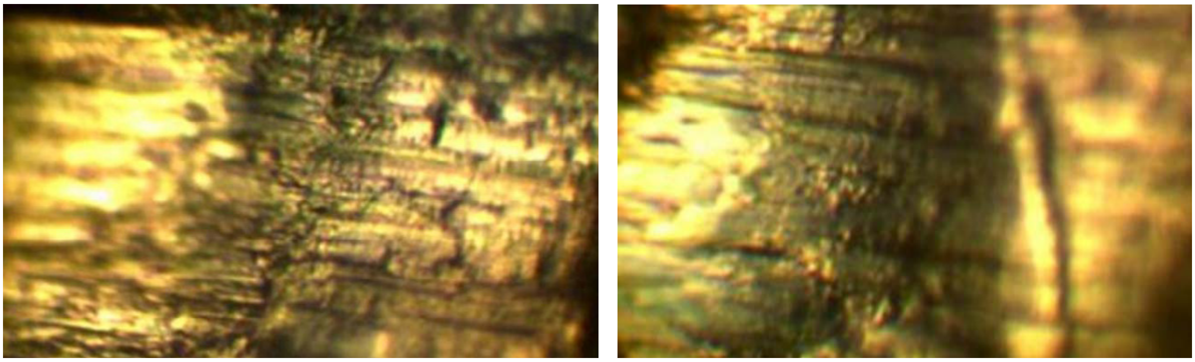

Fig. 3. Topographical microstructure of mild steel specimen after cutting

Fig. 4. Topographical microstructure of chip

4. Conclusion

This paper carried the use of imaging and pattern recognition techniques for the analysis of topographical microstructure of mild steel and its chip. The objective is to support research on influence on topographical microstructure in machining process. From this investigation it has been found that topographical microstructure of mild steel changes in different condition of cutting process. When the cutting speed was low, less crack and much black pearlite was formed compared to high speed condition. To optimize the surface characteristics additional cutting fluid should be provided during cutting. In future by a thermal imaging camera this investigation can be made so that it can attenuate the topographical microstructure of others metal more precisely.

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